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## DISTRIBUTIONAL PATTERNS OF THE NEOTROPICAL FLY GENUS *POLIETINA* SCHNABL & DZIEDZICKI (DIPTERA, MUSCIDAE): A PHYLOGENY-SUPPORTED ANALYSIS USING PANBIOGEOGRAPHIC TOOLS

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### ABSTRACT

*Over the last decades, Neotropical region has been subdivided into smaller units (areas of endemism), yet these subdivisions were not necessarily based on an evolutionary perspective. Consequently, these areas of endemism may be biogeographic units that do not actually represent natural historical units. Here, the distributional patterns of the genus Polietina Schnabl & Dzierżicki, 1911 (Diptera, Muscidae; including 15 species) are analysed by applying panbiogeographic tools to recognise and propose primary homologous areas within the Neotropical region. The analysis and discussion of the results obtained here will be reconciled to the information provided by the phylogenetic hypothesis available for the genus.*

KEYWORDS: Muscini, Neotropical, Panbiogeography, track analysis, nodes, biogeography.

### INTRODUCTION

During the last few decades, the Neotropical Region has been studied using a classification perspective; that is, it has been divided into smaller historical units (areas of endemism). Morrone (2001b) found 33 studies classifying the Neotropics into regions, subregions and provinces through several different criteria, e.g. geographic, palaeontological, faunistic and floristic. However, most studies did not propose a classification based upon an evolutionary perspective and, therefore, many of these classifications have used or defined biogeographic units that do not represent natural units (Morrone, 2001b). We find three comprehensive works as the most important contributions on this question: Cracraft (1985), in analysing the avi-

faunal distributional pattern, postulated 30 areas of endemism for South America (including west of the Andes and southernmost South America). Amorim & Pires (1996), using phylogenetic and biogeographic patterns of several animal groups, postulated that the Neotropics be divided into three main components: Caribbean, NW and SE components. The NW component comprised three smaller units: Andean-Mesoamerican, Southwest Amazonia and Northern Amazonia; whereas the SE component comprises Southeast Amazonia and the Atlantic Forest. Finally, Morrone (2001b) postulated that the region be divided into four subregions: Caribbean, Amazonian, Chacoan and Paraná. His proposal was based mostly on the panbiogeographic analysis of several animal and plant taxa.

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Panbiogeography comprises a first step towards the recognition of primary biogeographical homologies, followed by a second step, which is the confirmation of those primary hypotheses as secondary homologies (Morrone, 2001a, 2004). In this latter step, the primary homologies can be legitimate by the application of cladistic biogeographic methodology (the cladistic test, Morrone, 2001a).

Panbiogeographic tools can provide useful information through the generation of generalised tracks and nodes. Generalised tracks are obtained by the spatial overlapping of two or more individual tracks, which represent the spanning tree resulting from the minimal length connection of the known localities. The generalised tracks indicate the pre-existence of ancestral biota that became posteriorly fragmented by climatic and/or tectonic change (Craw *et al.*, 1999; Morrone & Crisci, 1995). They may also indicate the existence of areas of endemism, because areas of endemism would be equivalent to smaller generalised tracks (Grehan, 1993; Morrone, 2001a).

The genus *Polietina* Schnabl & Dziedzicki, 1911 comprises 15 species (Couri & Carvalho, 1997; Carvalho & Couri, 2002; Nihei, 2004a; Nihei & Carvalho, 2004) and ranges from the southern portion of the Nearctic region (southern USA) southwards to the southern Neotropics (northern Argentina, Paraguay and southern Brazil). *Polietina* was revised by Couri & Carvalho (1997), and complemented by the taxonomic contributions of Couri & Carvalho (1996), Couri & Pamplona (1997), Nihei (2002, 2004a) and Nihei & Carvalho (2004). More recently, Nihei (2004b) provided generic and specific diagnoses and an updated key to species, as well as performed cladistic and biogeographic analyses for this essentially Neotropical genus.

Here, we analysed the distributional patterns of *Polietina* by applying panbiogeographic tools to recognise and propose primary homologous areas within the Neotropical Region. The results obtained will be discussed based on the information provided by the phylogenetic hypothesis of the genus. The discussion will also approach the results published in earlier biogeographic studies focusing Muscidae and the Neotropical region.

## MATERIALS AND METHODS

We applied Panbiogeographic methods (following Morrone & Crisci, 1995 and Craw *et al.*, 1999) to analyse the distributional patterns of *Polietina* and to recognise spatial homologous areas. The known oc-

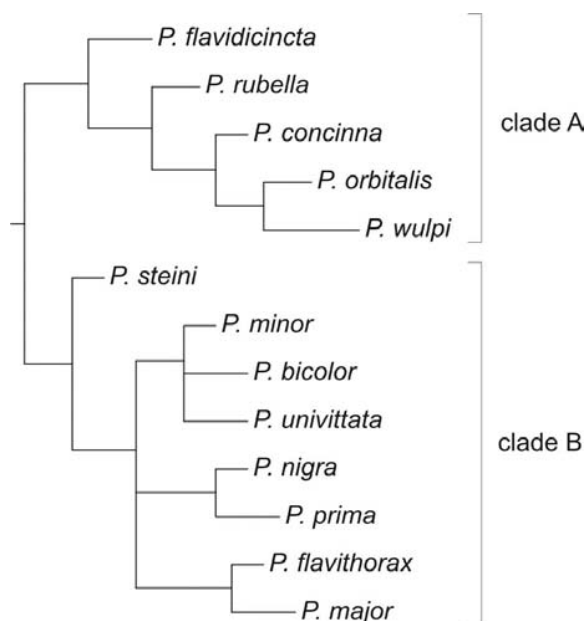
currence localities of each species (Appendix) were plotted into maps and connected by their minimal geographical distance to obtain individual tracks. Those individual tracks were gathered and overlapped to obtain generalised tracks for the genus. Generalised tracks indicate early existence of ancestral biotas which had been posteriorly fragmented by climatic and/or tectonic changes (Morrone & Crisci, 1995; Morrone & Márquez, 2001). Also, generalised tracks can indicate the existence of areas of endemism, since areas of endemism would equate to smaller generalised tracks (Morrone, 2001a; Harold & Mooi, 1994). However, Craw *et al.* (1999) emphasise that none proposition with regard to the biogeographic processes explaining tracks congruence is implied. Therefore, generalised tracks could represent 1) a track of a ancestral biota posteriorly subdivided through vicariance events, 2) a concordant dispersal pathway used concomitantly by the taxa, 3) isolated events of dispersal, or 4) a combination among these scenarios (Craw *et al.*, 1999).

Biogeographic nodes are complex areas that are recognised where occurs the meeting or overlapping of two or more generalised tracks (Craw *et al.*, 1999; Crisci *et al.*, 2003). Nodes serve as evidence that different ancestral biotic or geologic fragments are inter-related in space and time, resulting from terrain collision, docking or suturing, thereby indicating a composite area (Crisci *et al.*, 2003). Also, nodes may be described as areas that represent geographic and phylogenetic boundaries for the taxa of interest (Heads, 1989).

*Polietina* comprises 15 species (not all species were included in this study): *P. rubella* is known only from the type-locality and was not included in the track analysis; the type material for *P. basicincta* (Stein, 1904) and *P. mellina* (Stein, 1904) are missing, and their original descriptions are incomplete (Couri & Carvalho, 1997) and so they were not included. The sources of geographical data were Albuquerque (1956), Couri & Carvalho (1996, 1997), Couri & Pamplona (1997), Carvalho & Couri (2002), Nihei (2002, 2004a, b), and Nihei & Carvalho (2004) (see Appendix).

## RESULTS AND DISCUSSION

Based on geographical data available in the literature, the individual tracks for 12 species of *Polietina* (Figs. 2-3) generated 17 generalised tracks (Fig. 4) from the spatial congruence (overlapping) of the individual tracks. Species composition and the nature of each generalised track will be discussed and reconciled with



**FIGURE 1.** Phylogenetic relationships among *Polietina* species (modified from Nihei, 2004b).

the phylogenetic hypothesis proposed by Nihei (2004b) (Fig. 1).

A number of generalised tracks obtained for *Polietina* show congruence with the phylogenetic pattern (Fig. 4). Tracks 1-5 and 7 comprise the sister-species *P. nigra* and *P. prima*, while tracks 1 and 2 are supported exclusively by that clade. The polytomic clade *P. minor* + *P. bicolor* + *P. univittata* is present in the tracks 5, 6 and 9, although none of them is composed simultaneously by the three species. And, tracks 13 and 16 are supported by the clade *P. flavithorax* + *P. major*. Along with these tracks, track 5 is important because it contains nearly all species in clade B (Fig. 1), except for *P. bicolor* and *P. flavithorax*. However, these two species are present in other tracks contiguous with track 5: *P. bicolor* in track 6 (contiguous with track 5) and *P. flavithorax* in track 7 (contiguous with and partly overlapping track 5). That area, supported by tracks 5-7, is spatially coincident with the "Atl component" of Camargo & Pedro (2003) based on distributional patterns of Meliponine bees, and could represent an important area of endemism for the diversification of clade B. Similarly, the remaining tracks discussed above may represent areas of endemism for the species in question, especially tracks comprising closely related species. Generalised tracks might also indicate coincident or isolated dispersal events (Craw *et al.*, 1999), however, if phylogeny-supported, a track can indicate an area of endemism or the pre-existence of ancestral

biota for the concerned species. For example, generalised tracks formed by the sister-species *P. prima* and *P. nigra* probably indicate that the geographical area along which exists congruence in the distribution of these two contemporaneous species is a historically area, with importance to their diversification context.

Most generalised tracks were based on the distribution of species comprising clade B, and are concentrated in the SE component of Amorim & Pires (1996). This corroborates the suggestion that diversification of clade B is associated with that component (Nihei, 2004b). Clade A, on the other hand, was represented in several tracks only by *P. orbitalis* (widespread over SE component) (Fig. 4). With regard to the remainder of clade A, *P. rubella*, *P. concinna* and *P. wulpi* occur from southern Central America northward through Mexico to the southern USA, whereas *P. flavidicincta* is restricted to eastern Amazonian forests (see Figs. 2-3). The scarce geographical data for the species of clade A was the major limitation for generalised tracks in the Mesoamerican areas. Nevertheless, further collecting efforts on these areas could provide a rather sound and consistent analysis with regard to species of clade A and to Mesoamerica.

With respect to the subregions postulated by Morrone (2001b), some generalised tracks support some of his subregions. Tracks 3-12 are coincident with the Paraná subregion; and the individual tracks of *P. bicolor* (Fig. 2A), *P. minor* (Fig. 2F), and *P. univittata* (Fig. 3E), three closely related species that form a clade (Fig. 1), are exclusive to that subregion. The Amazonian subregion is supported by tracks 1 and 15-17 although they are restricted to the south of the Amazon River, and there is only one exclusive individual track, that of *P. flavidicincta* (Fig. 2C).

We compared the distributional patterns of *Polietina* with the patterns of the Muscidae genera studied by Carvalho *et al.* (2003). From that comparison, we intended to recognise eventual similarities between the patterns observed in *Polietina* and taxa belonging to the same family. In that study, those authors analysed the tracks of three muscid genera: *Cyrtoneurina* Gigliot, 1893, *Cyrtoneuroopsis* Malloch, 1925 and *Bithoracochaeta* Stein, 1911 (Figs. 6A-B, 7). Track 5 of *Polietina* is spatially coincident with track "g" of *Cyrtoneurina* (Fig. 6A), tracks "u" and "v" of *Cyrtoneuroopsis* (Fig. 6B), and track "d" of *Bithoracochaeta* (Fig. 7). Track 1 of *Polietina* is coincident with tracks "r" and "n" of *Cyrtoneuroopsis*, while track "f" of *Cyrtoneurina* superimposes to track 4 and partly to track 3 of *Polietina*. Of the tracks of *Cyrtoneurina*, *Cyrtoneuroopsis* and *Bithoracochaeta* that are congruent with *Polietina*, only

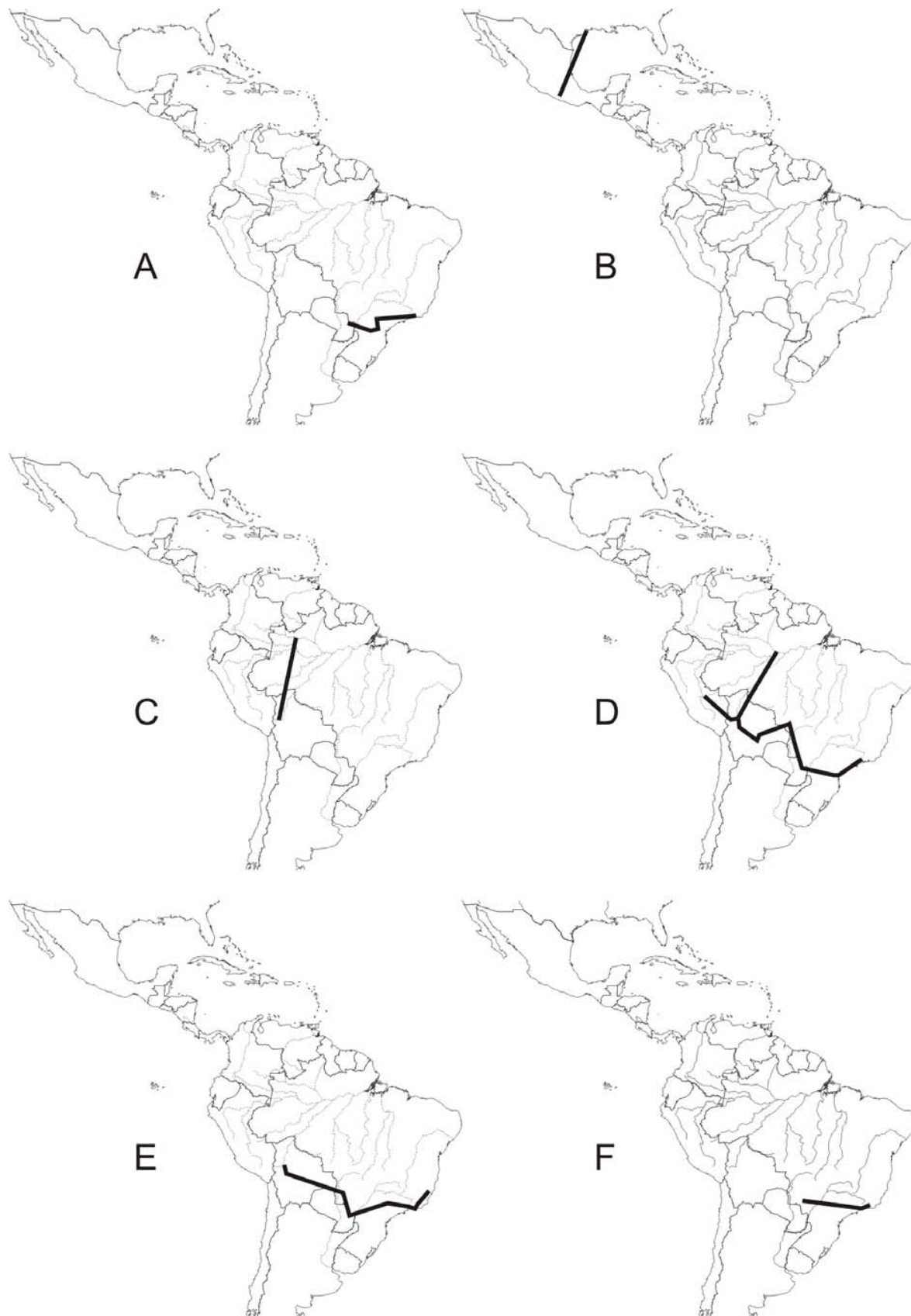


FIGURE 2. Individual tracks of *Polietina*. A, *P. bicolor*; B, *P. concinna*; C, *P. flavidicincta*; D, *P. flavithorax*; E, *P. major*; F, *P. minor*.



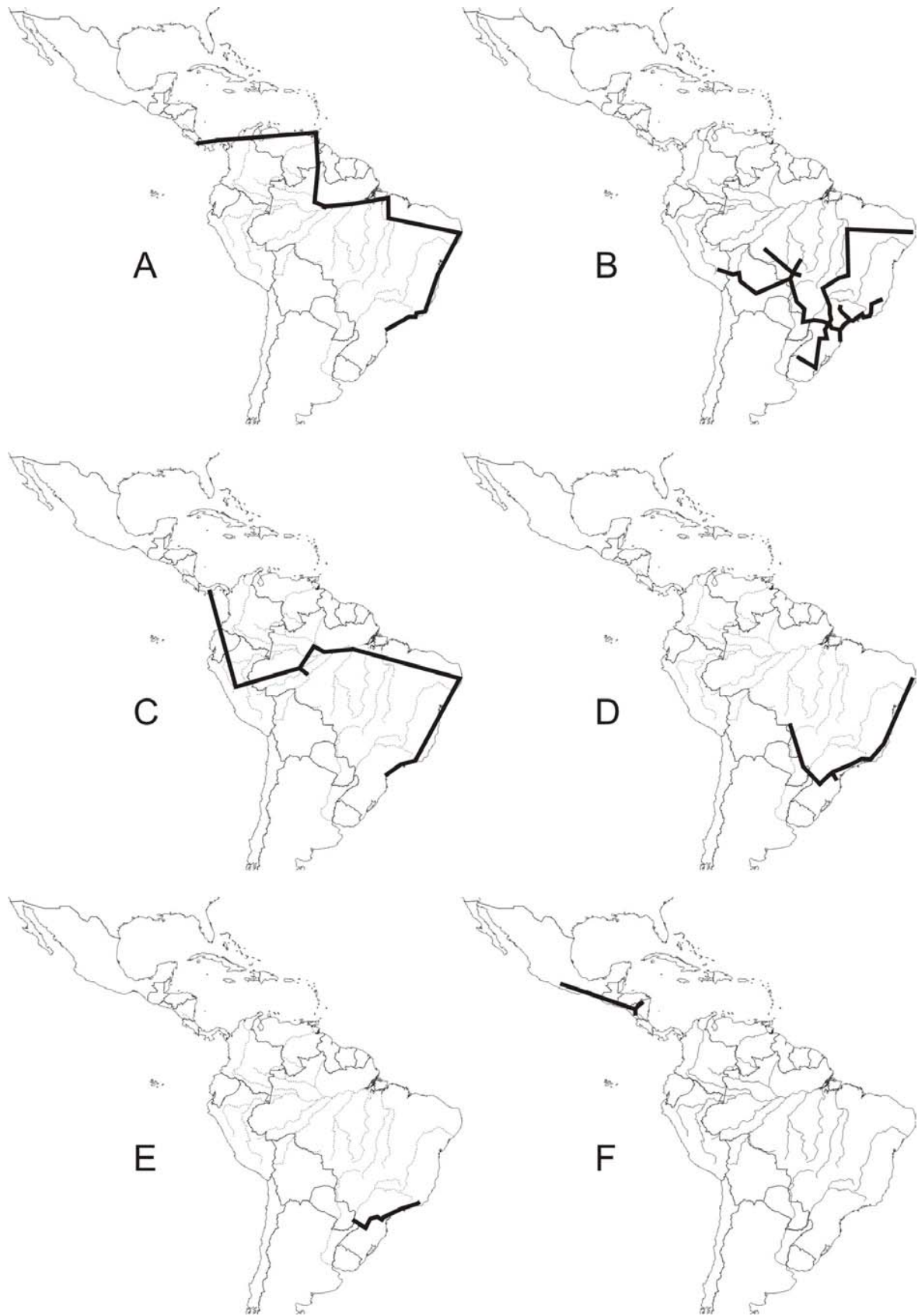


FIGURE 3. Individual tracks of *Polietina*. A, *P. nigra*; B, *P. orbitalis*; C, *P. prima*; D, *P. steini*; E, *P. univittata*; F, *P. vulpi*.

one was supported by the phylogenetic pattern available for each genus (Pamplona, 1999; Couri & Motta, 2000). Track “g” of *Cyrtoneurina* comprised four species, three of which (*C. geminata*, *C. costata*, *C. crispaseta*) are closely related taxa (Pamplona, 1999). Also, track “d” of *Bithoracochaeta* comprised two closely related, but not sister, species.

In this analysis, ten nodes were identified for *Polietina* (Fig. 5). Node “h” demarcates the southern

distribution of clade *P. nigra* + *P. prima*, whereas node “i” delimits the northern distribution of both clades *P. minor* + *P. bicolor* + *P. univittata* and *P. flavithorax* + *P. major* (see more on node “i” below, in comparison with nodes identified for other muscid genera). Hence, the geographical area between nodes “h” and “i” represents a sympatric zone among these three clades and also with *P. steini*, the most basal species in clade B. The latter species has its distribution delimited by the

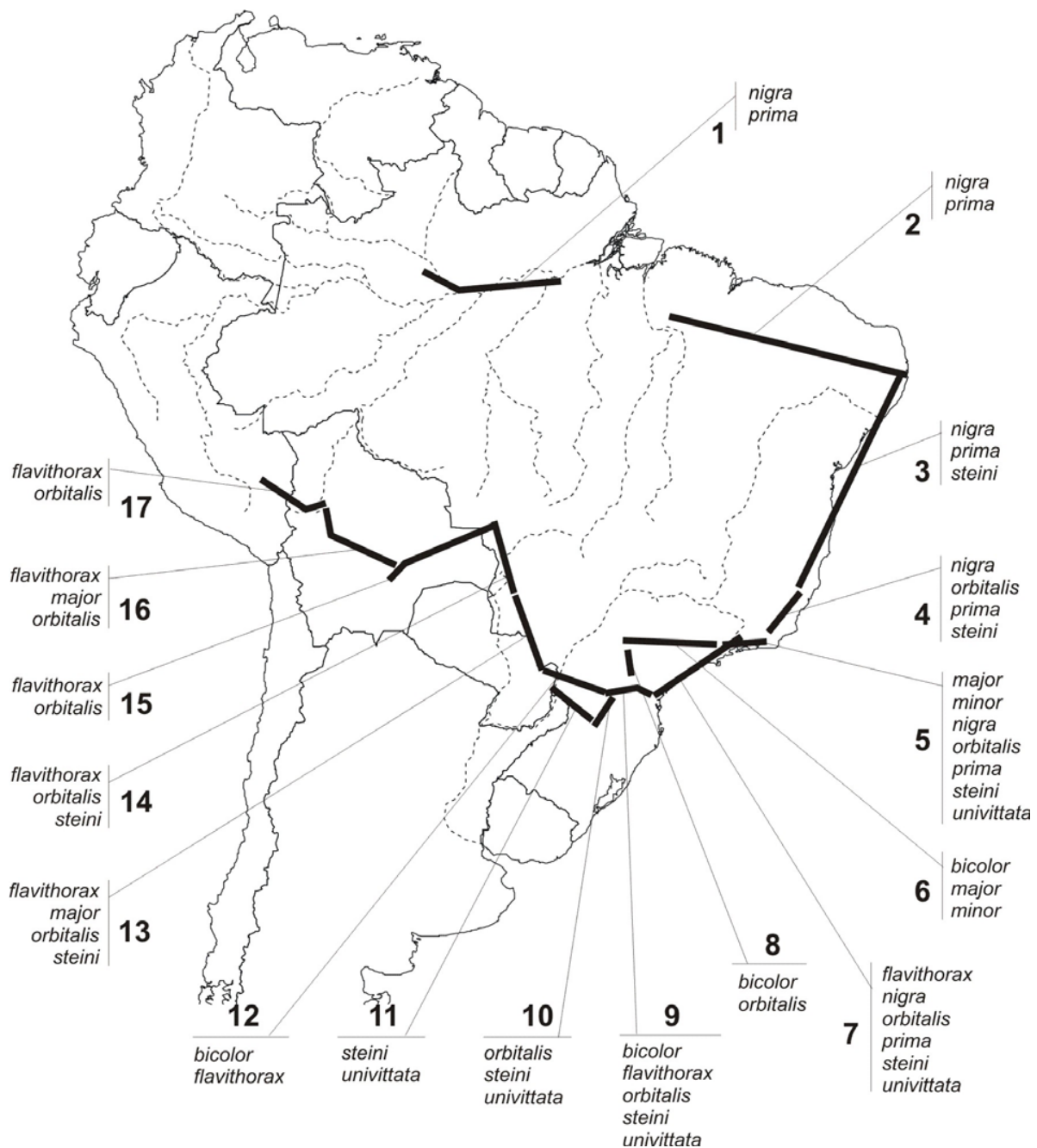


FIGURE 4. Generalised tracks obtained for *Polietina*, each one numbered and indicated its composing species.

nodes “c” and “j” (nodes as ‘distribution margins’ sensu Heads, 2004).

Some interesting information on vicariance, not recognised when analysing the generalised tracks and nodes, was possible to obtain only when considering the individual tracks isolatedly (Figs 8-9). Individual tracks of sister-species have indicated the possible location of areas of ancient vicariance among these spe-

cies. Figure 8 shows the individual tracks of the clade *P. concinna* + *P. rubella* + *P. vulpi* + *P. orbitalis* connected altogether, and the probable area of vicariance of that clade and the most basal species of clade A, *P. flavidicincta*. And Figure 9 shows the individual tracks of part of clade B (Fig. 1 depicts clade B with a basal polytomy, but Nihei, 2004, also supported a resolved solution with a sister-group relationship between

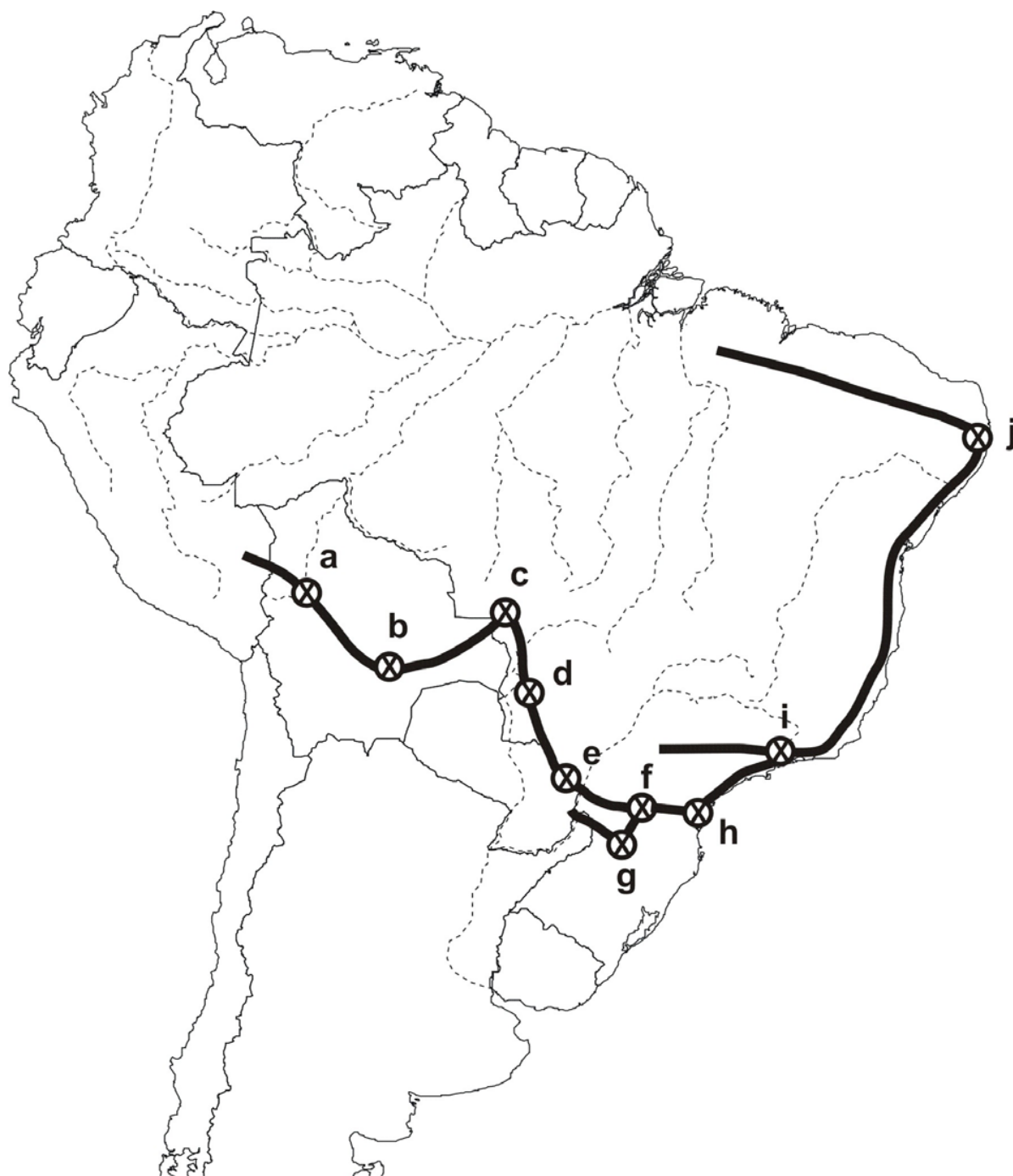


FIGURE 5. Biogeographical nodes identified from the generalised tracks of *Polietina*.

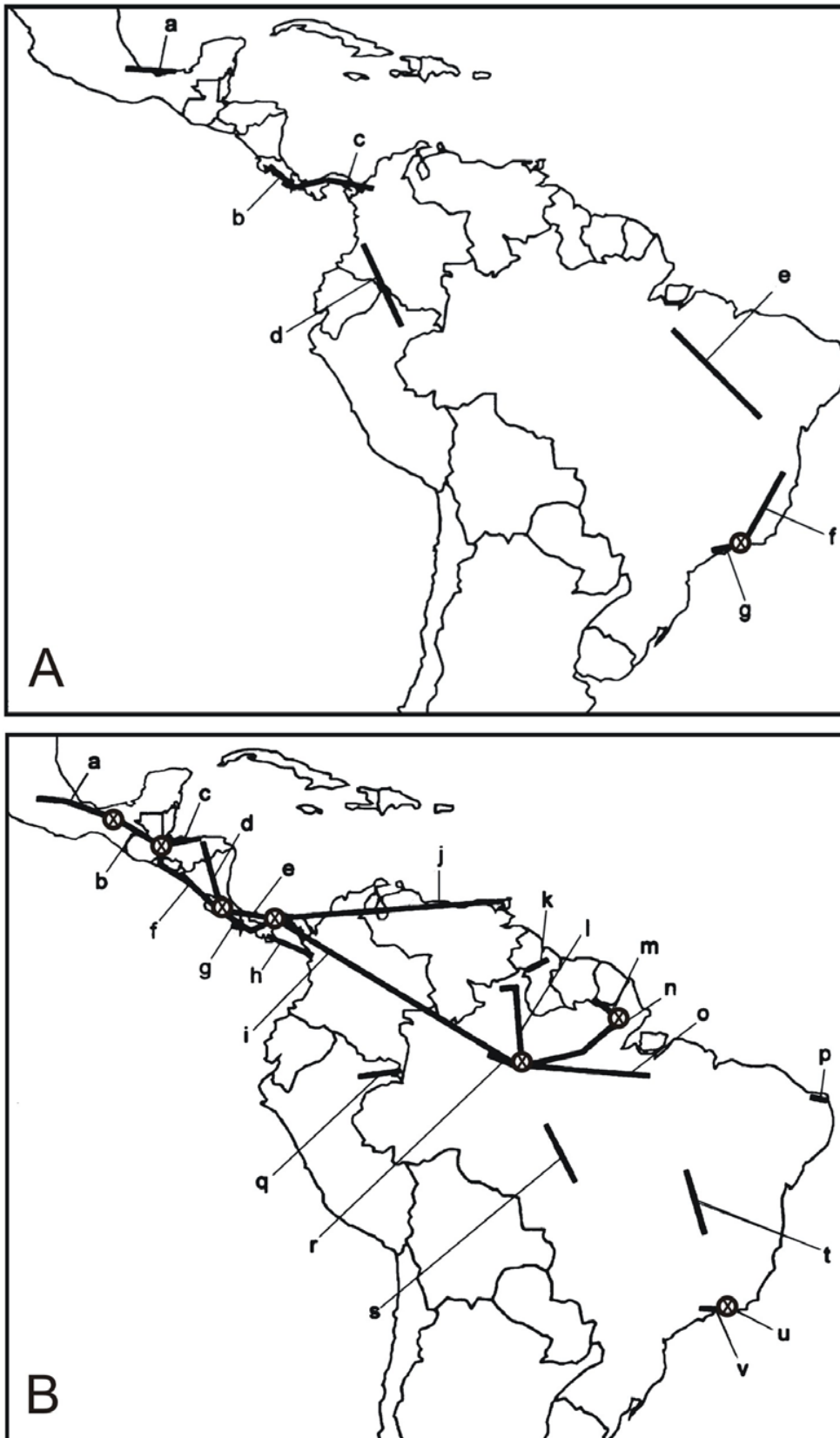


FIGURE 6. Generalised tracks and biogeographical nodes of *Cyrtoeurina* Giglio-Tos (A) and *Cyrtoeuropsis* Malloch (B) (modified from Carvalho *et al.*, 2003).



*P. prima* + *P. nigra* and *P. flavithorax* + *P. major*). The vicariance spots in the Amazon domain (Fig. 9) were not recognised in the nodes analysis (Fig. 5), on the other hand, the large area of vicariance recognised within the Atlantic Forest is partially represented by the nodes “h” and “i” (Fig. 5). Furthermore, the vicariance spot located more centrally in the Amazon domain is partially represented by the generalised track 1 (Fig. 4), whereas, the vicariance spot in Atlantic Forest is represented by several tracks (3, 4, 5, 6, 7).

We identified the nodes for the genera studied in Carvalho *et al.* (2003) (Figs. 6A-B, 7) and compared with *Polietina*. There is only one node congruent among *Polietina* (node “i”), *Cyrtoneurina*, *Cyrtoneuroopsis* and *Bithoracochoeta* on the Atlantic Forest domain. Unlike the other genera, with no recognized nodes in Amazonian Forest or Central America, *Cyrtoneuroopsis* has five nodes in those areas. For *Polietina*, this can be explained because most of the species are distributed southward to the Amazon River (Figs. 2-3), yet in *Cyrtoneuroopsis* most species occur in northeastern South America and Mesoamerica (see fig. 4 of Carvalho *et al.*, 2003).

Morrone (2003) identified four generalised tracks in the Neotropics on the basis of the distributional patterns of freshwater decapods of the family Trichodactylidae. The generalised tracks (named Caribbean, Amazonian, Chacoan and Paraná) strongly support the previously proposed subregions of Morrone (2001b). Morrone (2003) also identified three nodes: 1) in the southwest Colombia, between the Caribbean and Amazonian tracks; 2) in Bolivia, between the Amazonian and Chacoan tracks; and 3) in the border region of Argentina-Paraguay-Brazil, between the Chacoan and Paraná tracks. In the nodes of Trichodactylidae and *Polietina*, two nodes are nearly coincident. Node “a” of *Polietina* is congruent with the Bolivian node of Trichodactylidae, and node “e” is nearly congruent with the Argentina-Paraguay-Brazil node. These two nodes are clearly within and between the boundaries of the Amazonian and Chacoan, and the Chacoan and Paraná subregions, showing that the distributional patterns of Trichodactylidae and *Polietina* are congruent with that classification proposal of Morrone (2001b).



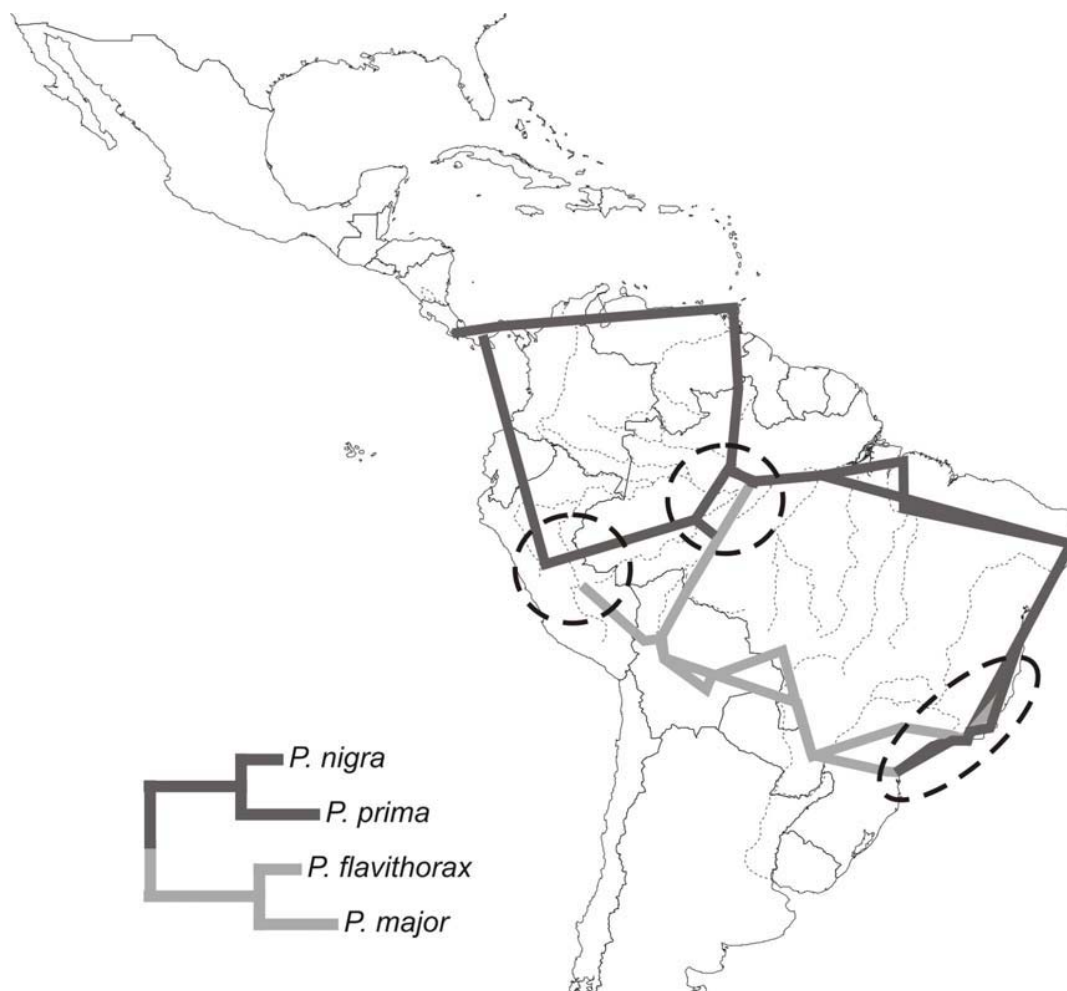
FIGURE 7. Generalised tracks and biogeographical node of *Bithoracochoeta* Stein (modified from Carvalho *et al.*, 2003).



**FIGURE 8.** Clade A and the individual tracks of its species. The gray circle representing the single locality known for *P. rubella*; the dashed gray line representing the connection between the northern track (*concinna* + *rubella* + *wulpi*) and *P. orbitalis* track; the dashed lined circle in black colour indicating area of ancient vicariance.

The nodes identified and discussed here may represent areas of great importance for the historical context of the diversification of these taxa, especially if one regards nodes as biogeographic boundaries of relict fragments of different ancestral biota coming into contact in the present day (Crisci *et al.*, 2003). Biogeographic nodes may also serve as the basis for the selection of priority areas for the proposition of conservation units (Grehan, 1993; Luna *et al.*, 2000), particularly if identification of the nodes is supported by phylogeny, *i.e.* they are meaningful within an evolutionary context. It means that the generalised tracks, as well as the nodes, are not randomly composed by two or more unrelated species; they are comprised by species with a common history on Earth. To identify the nature of biogeographic nodes is a very complex task. Some studies have been concerned to present and discuss the nature of biogeographic nodes on theoretical

grounds (Heads, 1989, 2004), however, in practice, it is very complicate to 'give' a node a specific nature and a scientific explanation. In the present study, we provided some examples where a biogeographic node could indicate the existence of an area of ancient vicariance (see node "a" of Fig. 5, and the area of vicariance of Fig. 8; and nodes "h" and "i" and the area of vicariance on Atlantic Forest indicated in Fig. 9). Morrone (2001a, also Morrone & Crisci, 1995) stressed the importance of an integrative view in the biogeographic practice, and recommended the reconciliation of different methodologies, each one being used for a specific aim within the study. In the present study, we did not apply any additional methodology other than the panbiogeographic tools used to recognise and support the nodes, however, we have sustained our discussion on the basis of the phylogenetic relationships among the species of *Polietina*. Be-



**FIGURE 9.** Part of clade B and the individual tracks of its species. The dashed lined areas (circles and ellipse) in black colour indicating areas of ancient vicariance between the clades *P. prima* + *P. nigra* and *P. flavithorax* + *P. major*.

cause sister-taxa are contemporaneous in the time scale and share a common history on Earth, the generalised tracks formed by them are historically more important than tracks comprised randomly by taxa derived from distant lineages. The same interpretation can be extended to biogeographic nodes, *i.e.*, where a given generalised track comprised by clade X meets another track comprised by clade Y forming a node and knowing that clades X and Y are sister-groups.

We believe that our results, in addition to earlier works, provides an accumulative basis for further studies focusing the study of biogeographic homologies within the Neotropical region. For example, the nature of nodes was not fully demonstrated herein, although we hope subsequent studies can advance on this subject and identify possible ancient geological events responsible for the location of the nodes recognised here.

## RESUMO

*Durante as últimas décadas, a Região Neotropical tem sido classificada em unidades históricas menores (áreas de endemismo), entretanto, muitos desses estudos não têm se preocupado em propor uma classificação sob uma perspectiva evolutiva. Conseqüentemente, uma determinada classificação pode considerar unidades biogeográficas que não representem realmente unidades naturais. No presente estudo, o padrão de distribuição do gênero Polietina Schnabl & Dziejewski, 1911 (Diptera, Muscidae), com 15 espécies, é analisado pela aplicação de ferramentas da Pan-biogeografia para reconhecer e propor áreas de homologia primária na região Neotropical. A análise e discussão dos resultados aqui obtidos serão conciliados às informações fornecidas pela hipótese filogenética disponível para o gênero.*

**PALAVRAS-CHAVE:** Muscini, Neotropical, Pan-biogeografia, análise de traços, nós, biogeografia.

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## REFERENCES

- Albuquerque, D.O. 1956. Fauna do Distrito Federal. XIII. Sobre o gênero *Polietina* Schnabl & Dziedzicki, 1911, com descrições de espécies novas (Diptera, Muscidae). *Boletim do Museu Nacional*, Nova Série, Zoologia, 139:1-31.
- Amorim, D.S. & Pires, M.R.S. 1996. Neotropical biogeography and a method for maximum biodiversity estimation. In: Bicudo, C.E.M. & Menezes, N.A. (Eds.), *Biodiversity in Brazil, a first approach*. CNPq, São Paulo, p.183-219.
- Camargo, J.M.F. & Pedro, S.R.M. 2003. Meliponini neotropicais: o gênero *Partamona* Schwarz, 1939 (Hymenoptera, Apidae, Apinae) – bionomia e biogeografia. *Revista Brasileira de Entomologia*, 47:311-372.
- Carvalho, C.J.B. de; Bortolanza, M.; Silva, M.C.C. & Soares, E.D.G. 2003. Distributional patterns of the Neotropical Muscidae (Diptera). In: Morrone, J.J. & Llorente, J. (Eds.), *Una perspectiva latinoamericana de la Biogeografía*. Las Prensas de Ciencias, Facultad de Ciencias, UNAM, Mexico D.F., p.263-274.
- Carvalho, C.J.B. de & Couri, M.S. 2002. Basal groups. Part I. In: Carvalho, C.J.B. de (Ed.), *Muscidae (Diptera) of the Neotropical Region: taxonomy*. Editora Universidade Federal do Paraná, Curitiba, p.17-132.
- Cracraft, J. 1985. Historical biogeography and patterns of differentiation within the South American avifauna: areas of endemism. In: Buckley, P.A.; Foster, M.S.; Morton, E.S.; Ridgely, R.S. & Buckley, F.G. (Eds.), *Neotropical ornithology*. Ornithological Monographs 36. The American Ornithologists' Union, Washington, D.C., p.49-84.
- Couri, M.S. & Carvalho, C.J.B. de. 1996. Duas novas espécies de *Polietina* Schnabl & Dziedzicki (Diptera, Muscidae) do Brasil. *Revista Brasileira de Zoologia*, 12:825-831, [1995].
- Couri, M.S. & Carvalho, C.J.B. de. 1997. Revision of *Polietina* Schnabl & Dziedzicki (Diptera, Muscidae) and considerations on its new systematic position. *Revista Brasileira de Zoologia*, 14:255-281.
- Couri, M.S. & Motta, H.C.G. 2000. Análise cladística de *Bilboracochaeta* Stein (Diptera, Muscidae). *Revista Brasileira de Entomologia*, 44:105-108.
- Couri, M.S. & Pamplona, D.M. 1997. Sobre a identidade de quatro espécies descritas em *Cyrtoneurina* Giglio-Tos com diagnoses e redescritão (Diptera, Muscidae). *Revista Brasileira de Biologia*, 57:411-415.
- Craw, R.C.; Grehan, J.R. & Heads, M.J. 1999. *Panbiogeography: tracking the history of life*. Oxford University Press, New York.
- Crisci J.V.; Katinas, L. & Posadas, P. 2003. *Historical biogeography: an introduction*. Harvard University Press, Cambridge.
- Grehan, J.R. 1993. Conservation biogeography and the biodiversity crisis: a global problem in space/time. *Biodiversity Letters*, 1:134-140.
- Harold, A.S. & Mooi, R.D. 1994. Areas of endemism: definition and recognition criteria. *Systematic Biology*, 43:261-266.
- Heads, M.J. 1989. Integrating earth and life sciences in New Zealand natural history: the parallel arcs model. *New Zealand Journal of Zoology*, 16:549-585.
- Heads, M.J. 2004. What is a node? *Journal of Biogeography*, 31:1883-1891.
- Luna, I.; Alcántara, O.; Morrone, J.J. & Espinosa, D. 2000. Track analysis and conservation priorities in the cloud forests of Hidalgo, Mexico. *Diversity and Distribution*, 6:137-143.
- Morrone, J.J. 2001a. Homology, biogeography and areas of endemism. *Diversity and Distributions*, 7:297-300.
- Morrone, J.J. 2001b. *Biogeografía de América Latina y el Caribe*. Manuales & Tesis SEA 3. Sociedad Entomológica Aragonesa, Zaragoza.
- Morrone, J.J. 2003. Homología biogeográfica primaria de la familia Trichodactylidae (Crustacea: Decapoda). In: Morrone, J.J. & Llorente, J. (Eds.), *Una perspectiva latinoamericana de la Biogeografía*. Las Prensas de Ciencias, Facultad de Ciencias, UNAM, Mexico D.F., p.241-245.
- Morrone, J.J. 2004. Panbiogeografía, componentes bióticos y zonas de transición. *Revista Brasileira de Entomologia*, 48:149-162.
- Morrone, J.J. & Crisci, J.V. 1995. Historical biogeography: introduction to methods. *Annual Review of Ecology and Systematics*, 26:373-401.
- Morrone, J.J. & Márquez, J. 2001. Halfiter's Mexican Transition Zone, beetle generalized tracks, and geographical homology. *Journal of Biogeography*, 28:635-650.
- Nihei, S.S. 2002. *Polietina* Schnabl & Dziedzicki (Diptera, Muscidae): description of the male of *P. major* Albuquerque and female of *P. wulpi* Couri & Carvalho. *Revista Brasileira de Entomologia*, 46:529-533.
- Nihei, S.S. 2004a. Review of the type material of three species of *Polietina* Schnabl & Dziedzicki (Diptera, Muscidae). *Revista Brasileira de Entomologia*, 48:21-25.
- Nihei, S.S. 2004b. *Sistemática e biogeografia de Muscini (Diptera, Muscidae)*. Tese (Doutorado). Universidade Federal do Paraná, Curitiba.
- Nihei, S.S. & Carvalho, C.J.B. de. 2004. Description of the male of *Polietina prima* (Couri & Machado) and new synonymies in the genus *Polietina* Schnabl & Dziedzicki (Diptera, Muscidae). *Studia Dipterologica*, 10:665-672.
- Pamplona, D.M. 1999. Nova caracterização de *Cyrtoneurina* Giglio-Tos, 1893 e descrição de *Paracyrtoneurina* gen. nov. (Diptera, Muscidae). *Revista Brasileira de Zoologia*, 43:9-24.

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## APPENDIX

**Geographical data of *Polietina* compiled for the biogeographic analysis (in the brackets, the latitude and longitude, respectively).**

*Polietina bicolor*: BRAZIL: *Rio de Janeiro*: Tinguá (-22.600, -43.433), Angra dos Reis (-23.000, -44.3000), Itatiaia (-22.5000, -44.5667), Rio de Janeiro (-22.9000, -43.2333); *Paraná*: Jundiá do Sul (-23.4500, -50.2833), Guarapuava (-25.3833, -51.4500), Ponta Grossa (-25.0833, -50.1500); PARAGUAY, *Canindeyú*, Reserva Natural Bosque Mbaracayú (-24.0000, -55.4166).

*Polietina concinna*: USA, *Texas*, Galveston (29.300, -94.783); MEXICO, *Guerrero*, Xucumanatlan [Xocomanatlan, Chilpancingo de Los Bravo] (17.5500, -99.6333).

*Polietina flavidicincta*: BOLIVIA, *La Paz*, Mapiri (-15.2500, -68.1667); BRAZIL, *Amazonas*, Santa Izabel, Rio Negro, Pico da Neblina, 2030m (-0.4000, -65.0333).

*Polietina flavithorax*: BRAZIL: *Amazonas*, Reserva Ducke (-02.8833, -59.9666); *Rondônia*, Guajará-Mirim, R. Pacaás Novos (-11.1833, -64.8500); *Mato Grosso*, Cáceres (-16.067, -57.683); *Mato Grosso do Sul*, Miranda (-20.1666, -56.5166); *Rio de Janeiro*, Parque Nacional do Itatiaia (-22.5000, -44.5667); *Paraná*: Curitiba (-25.417, -49.417); Morretes (-25.4667, -48.8167); São José dos Pinhais (-25.5167, -49.2167); PERU, *Ucayali*, Meshagua [Mishagua], Urubamba [rio] (-11.2047, -72.9922); BOLIVIA: *La Paz*, Sarampioni, Mapiri (-15.2500, -68.1667); *Santa Cruz*: Las Trancas (-18.100, -63.3167); Vallegrande, Masicurí (-18.8000, -63.7666); *Beni*, Yacuma (-15.1667, -67.0667); *Cochabamba*, Ayopaya (Seque Rancho, Rio Cotacajes) (-16.5333, -66.8833); PARAGUAY, *Canindeyú*, Reserva Natural Bosque Mbaracayú (-24.0000, -55.4166).

*Polietina major*: BRAZIL: *Espírito Santo*, Itaguaçu (-19.8000, -40.8500); *Mato Grosso do Sul*, Salobra [Miranda] (-20.1666, -56.5166); *Rio de Janeiro*, Teresópolis (-22.4000, -42.9500); Rio de Janeiro (-22.8833, -43.2166); Itatiaia (-22.5000, -44.5667); Deodoro (-22.8547, -43.3847); *São Paulo*, Boa Esperança do Sul (-21.9833, -48.3833); PARAGUAY, *Canindeyú*, Reserva Natural Bosque Mbaracayú (-24.0000, -55.4166); BOLIVIA: *Beni*: Yacuma (-15.1667, -67.0667); *Cochabamba*, Ayopaya (Rio Cotacajes) (-16.5333, -66.8833).

*Polietina minor*: BRAZIL: *Mato Grosso do Sul*, Maracaju (-21.6333, -55.1500); *Rio de Janeiro*, Angra dos Reis (-23.000, -44.3000); Teresópolis (-22.4500, -42.9833).

*Polietina nigra*: COSTA RICA, *Puntarenas*: P.N. Corcovado (8.4500, -83.5166); PANAMA, *Canal Zone*, Madden (9.1667, -79.5500); TRINIDAD & TOBAGO, Trinidad, B.W.I. [aproximated by the capital Puerto España] (10.65, -61.5166); BRAZIL: *Roraima*, Serra Pacaraima (4.4500, -61.1333); *Amazonas*: Reserva Ducke (26 km NE Manaus) (-02.8833, -59.9666); Manaus (-3.1133, -60.0253); Parque Nacional do Jaú (Rio Carabinani) (-02.0100, -61.6000); *Pará*: Benevides (-1.3667, -48.2500); Santarém (-2.433, -54.700); *Maranhão*, São Pedro da Água Branca (-04.9833, -48.1333); *Pernambuco*, Vicência (-7.6667, -35.3333); *Bahia*, Una (10 km SE São José) (-15.3000, -39.0667); *Rio de Janeiro*: Teresópolis (-22.4333, -42.9833); Angra dos Reis (-23.000, -44.3000); Palmeiras (-22.0500, -41.4833); Rio de Janeiro (-22.8833, -43.2166); *Paraná*: Antonina (-25.4500, -48.7167).

*Polietina orbitalis*: BRAZIL: *Maranhão*: Carolina, Serra Grande (-07.0666, -47.4000); Carolina, Fazenda Marajá (-07.2500, -47.3666); *Pernambuco*: Vicência (-7.6667, -35.3333); *Rondônia*, Ouro Preto d'Oeste (-10.6666, -62.3000); *Goiás*: Corumbá (-15.9167, -48.8000); Jataí (-17.8833, -51.7167); *Distrito Federal*, Planaltina (15°35'S/47°42'W); *Mato Grosso*: Barra do Bugres (-15.0833, -57.1833); Cáceres (-16.067, -57.683); Sinop (-12.5166, -55.6166); Chapada dos Guimarães (-15.4333, -55.7500) *Mato Grosso do Sul*: Maracaju (-21.6333, -55.1500); Miranda (-20.1666, -56.5166); *Minas Gerais*: Viçosa (-20.7500, -42.8833); *Espírito Santo*, Itaguaçu (-19.8000, -40.8500); *Rio de Janeiro*: Angra dos Reis (-23.000, -44.3000); Itatiaia (-22.5000, -44.5667); Mangaratiba (-22.9500, -44.0333); Rio de Janeiro (-22.8833, -43.2166); Teresópolis (-22.4000, -42.9500); *São Paulo*: Andes (-21.0050, -48.4666); Araçatuba (-21.2000, -50.4167); Assis (-22.6667, -50.4167); Barueri (-23.5167, -46.8833); Bertioga (-23.8500, -46.1500); Boa Esperança do Sul



(-21.9833, -48.383); Eldorado Paulista (-24.5333, -48.1000); Itu (-23.2667, -47.3167); Jundiá (-23.1833, -46.8667); Nova Europa (-21.7667, -48.5500); São Paulo (-23.5333, -46.6167); *Paraná*: Antonina (-25.4500, -48.7167); Colombo (-25.2833, -49.2333); Curitiba (-25.417, -49.417); Engenheiro Beltrão (-23.7833, -52.2500); Fênix (-23.9000, -51.9500); Guarapuava (-25.3833, -51.4500); Jundiá do Sul (-23.4500, -50.2833); Morretes (-25.4667, -48.8167); Ponta Grossa (-25.0833, -50.1500); São José dos Pinhais (-25.5167, -49.2167); Telêmaco Borba (-24.3500, -50.6167); Umuarama (-23.7500, -53.3333); *Santa Catarina*: Florianópolis (-27.5833, -48.5667); Nova Teutônia (-27.0500, -52.4000); Rio das Antas (-26.9167, -51.0667); *Rio Grande do Sul*: Arroio Grande (-32.2333, -53.0833); Quaraí (-30.3833, -56.4500); PERU, Vilcanota (-14.4500, -70.9667); BOLÍVIA: *La Paz*, Mapiri (-15.2500, -68.1667); *Santa Cruz*, Loma Larga (-18.7500, -63.9000); *Beni*, Yacuma (-15.1667, -67.0667); PARAGUAY, *Canindeyú*, Reserva Natural Bosque Mbaracayú (-24.0000, -55.4166).

*Polietina prima*: PANAMA, *Darien*, Santa Fé (8.4833, -80.8333); PERU, *Huánuco*, Tingo María (-9.3000, -75.9833); BRAZIL: *Amazonas*: Parque Nacional do Jaú (Ig. Miracatu/Ig. do Gerleí) (-01.9500, -61.8166); Reserva Ducke (26 km NE Manaus) (-02.8833, -59.9666); Puruzinho (-5.8856, -64.4094); Restauração (-7.0500, -62.8833); *Pará*, Santarém (-2.4333, -54.7000); *Pernambuco*, Vicência (-7.6667, -35.3333); *Rondônia*, Ariquemes (-09.7333, -61.8666); *Rio de Janeiro*, Rio de Janeiro (-22.9000, -43.2333); *São Paulo*, Salesópolis (-23.5333, -45.8500); *Paraná*, Antonina (-25.4500, -48.7167).

*Polietina rubella*: MEXICO, *Guerrero*, Omilteme [Omiltemi, Chilpancingo de Los Bravo] (17.5000, -99.6667).

*Polietina steini*: BRAZIL: *Pernambuco*, Vicência (-7.6667, -35.3333); *Mato Grosso*, Cáceres (-16.067, -57.683); *Espírito Santo*, Itapina (-19.583, -40.617); *Rio de Janeiro*: Itatiaia (-22.5000, -44.5667); Petrópolis (-22.500, -43.100); *São Paulo*, Barueri (-23.5167, -46.8833); *Paraná*, Marumbi (Rio Azul) (-25.7000, -50.817); Ponta Grossa (Vila Velha) (-25.0833, -50.1500); *Santa Catarina*: Nova Teutônia (-27.0500, -52.4000); Colônia Hansa [Corupá] (-26.4166, -49.2333); PARAGUAY, *Canindeyú*, Reserva Natural Bosque Mbaracayú (-24.0000, -55.4166).

*Polietina univittata*: BRAZIL: *Rio de Janeiro*: Nova Friburgo (-22.267, -42.567); Petrópolis (-22.500, -43.100); Teresópolis (-22.4333, -42.9833); *São Paulo*, Salesópolis (-23.533, -45.850); *Paraná*: Colombo (-25.2833, -49.2333); Curitiba (-25.417, -49.417); Guarapuava (-25.3833, -51.4500); Ponta Grossa (-25.0833, -50.1500); *Santa Catarina*, Nova Teutônia (-27.0500, -52.4000); ARGENTINA, *Misiones*, Iguazu Nat. Park (-25.5666, -54.5666).

*Polietina vulpi*: MEXICO, *Guerrero*, Xucumanatlan [Xocomanatlan, Chilpancingo de Los Bravo] (17.5500, -99.6333); NICARAGUA: *Granada*, Volcan Mombacho (11.8333, -85.9666); *Matagalpa*, Fuente Pura (13.0333, -85.9333); *Jinotega*, Peñas Blancas (13.2833, -85.6333); *Zelaya*, Rio Waspuq, Sulum (14.2500, -84.6000).

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